Stopping the Invasion:

Eliminating Aquatic Nuisance Species Using Ozone

Nutech-O3 INC.

Overview

- Who is Nutech?
- Background information on Ozone
- What are the challenges/advantages?
- Testing Protocol/Floating Laboratory
- Test Results
- Focus of future testing

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The Nutech Team:

- Marine Biologists
- Chemists
- Marine Engineers
- Naval Architects
- Academic Researchers
- Corrosion Engineers
- Environmental Scientists
- Ship Owners & Operators

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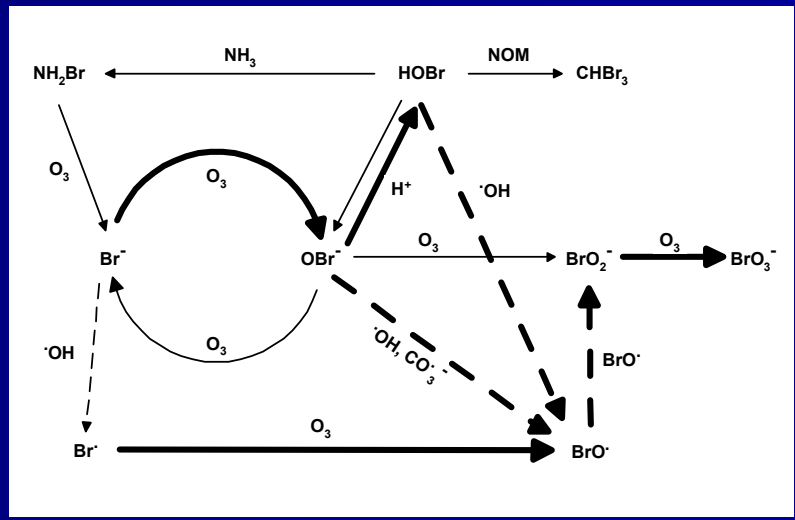
Background information…

- What is ozone?
- How is it made?
- How does it work?
  - Biologically
  - Chemically
- Other proven applications



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This is Ozone (O_3)...

- Ozone is a powerful oxidation agent
- Easily soluble in water
- Colorless gas, with distinctive odor
- Extremely short half-life; after which O_3 reverts to O_2

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This is how you "make" Ozone…

- Nitrogen is stripped from ambient air to concentrate the oxygen content
- Oxygen is passed through a high voltage or high frequency electrical field
- A percentage of the O_2 molecules are converted to O_3 molecules
- O_3 is then injected into the water stream utilizing diffusers or venturi technology

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This is how it works – Biologically and Chemically…

- O3 reacts with other constituents normally found in sea water
- The reaction creates Hypobromous acid (HOBr) and Hypobromite ion (OBR-)
- These oxidants are the "killing" mechanism when their levels exceed a toxic threshold

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Other water treatment uses for O_3...

- Municipal drinking water systems
- Bottled water suppliers
- Soda bottlers
- Breweries and Distilleries
- Commercial laundry facilities
- Sewage treatment plants
- Any place sterile water is needed

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Technical *challenges* related to O_3

- Ozone is toxic to humans as well; how can we safely handle it on board ship?
- Ozone has a very short half-life in sea water (3-4 seconds); so how do we get it to do its job in such a short time?
- How do we make sufficient amounts of ozone to treat so much water?
- Latent toxicity, if any, needs to be neutralized

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Technical *advantages* related to O_3

- Ozone is not sensitive to solids content in the water; therefore, no "pre-treatment" required
- Ozone has been proven NOT to accelerate corrosive forces already at work in sea water, at the dosage levels needed
- Ozone appears to be so effective at "killing" that it prevents re-growth

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Issues that all ANS technologies must show they can deal with…

- What is the efficacy of the treatment especially compared to BWE?
- What are the dosage rates required to achieve this?
- What are the re-growth rates, if any?
- What are the economics involved?
  - Capital purchase costs
  - Installation costs
  - Operating and maintenance costs vs. cost of BWE

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Development of the testing protocol

- All members of the Team were involved:
  - Academics
  - Scientists
  - Ship designers
  - Ship operators
- Real world or laboratory testing?
- What exactly would we test for?
- Against what performance standard(s)?
- Peer reviewed and approved

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Engineering and Technical

- Ozone had never been used on board ships in the treatment of ballast water
- Regulatory (USCG, ABS) review was intense
- Owner/Operator scrutiny was also intense; focus on personnel and operational safety
- Space on the subject vessel was at a premium
- How should the ozone be distributed?
- Who would operate the equipment and perform the testing?

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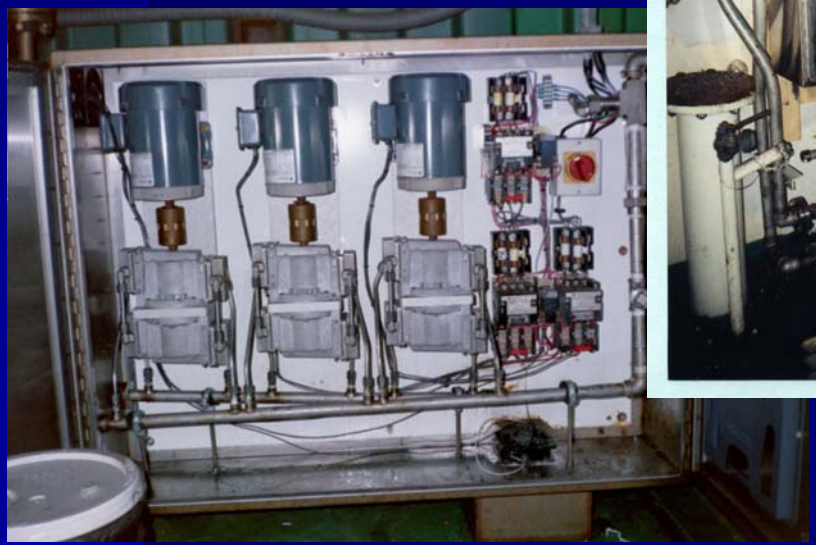
Our floating "Laboratory"

- T/V Tonsina, a 125,000 dwt tanker
- Owned by BP Oil Co.; operated by Alaska Tanker Co.
- 869' LOA x 136' beam
- Cargo capacity of 824,000 bbls (~ 34.6 million gallons)
- Ballast capacity of 306,500 bbls (~ 12.9 million gallons)

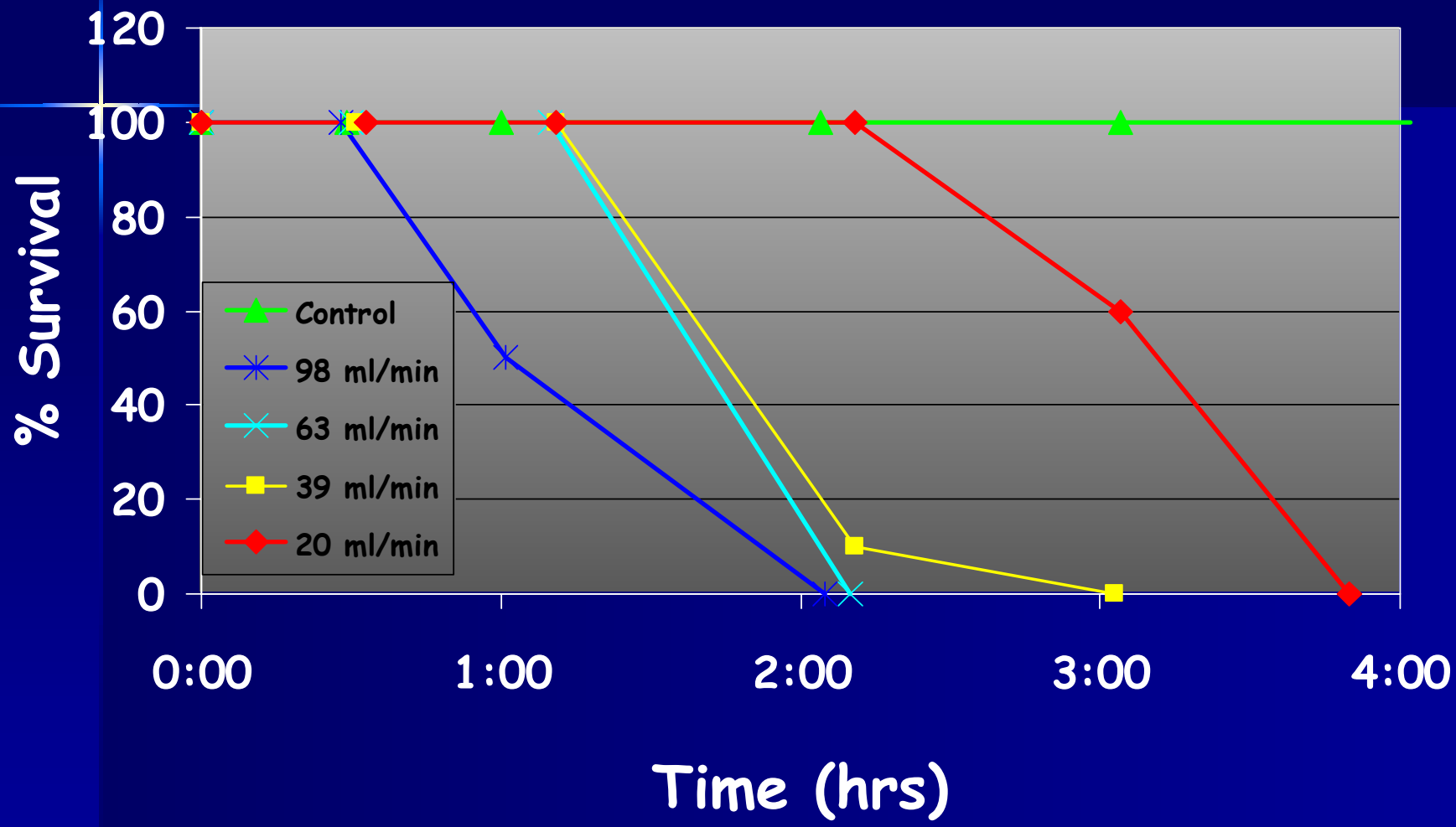
Equipment Installation

PG
pixels



On board testing

Test Results



O_3 concentration: 0.07 mg O_3/ml

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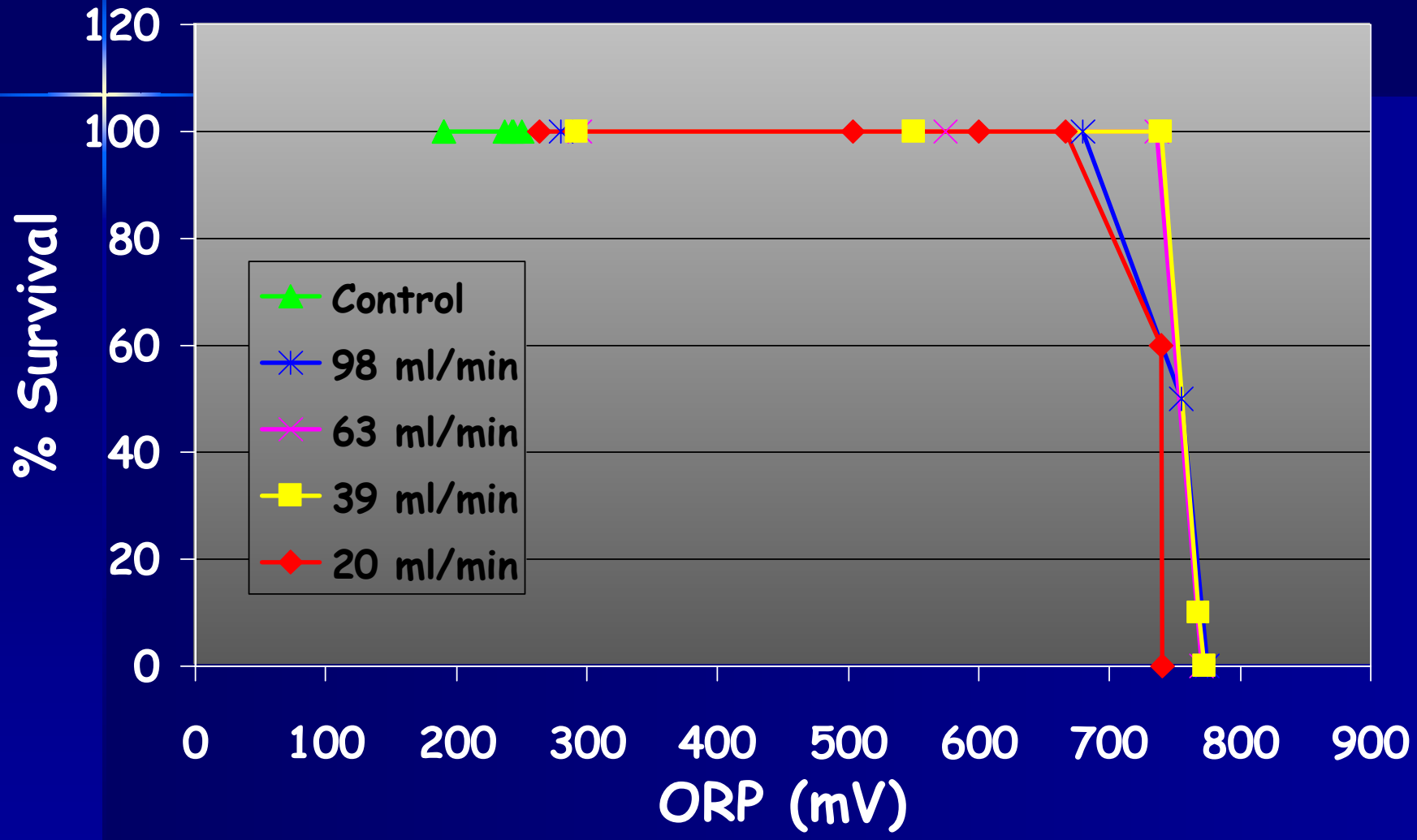
Test results



O_3concentration: 0.07 mg O_3/ml

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Focus of next stage of testing

- **Scientific:**
  - How much of the killing is being done by the ozone vs. the oxidants produced by the ozone?
  - Will latent toxicity be an issue?
  - How can we best measure, in real time, the ability of the water to support life, and therefore the efficiency of our dosage rate?

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Focus of next stage of testing (cont'd)

- **Engineering:** Our testing to date has proven that ozone works. Our focus is now turning towards what can be done to:
  - Reduce the installation costs
  - Maximize the production rate of ozone for the power consumed
  - Optimize the distribution method of the ozone
  - Determine the optimal quantity of ozone needed to achieve the desired "kill" rate

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Thank you!


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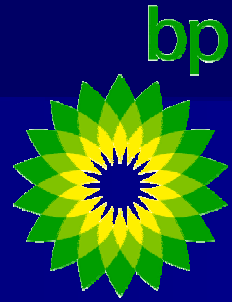
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